United States Department of Agriculture
Marketing and Regulatory Programs
Animal and Plant Health Inspection Service

Administrative Notice **APHIS 11-3** **2/16/11**

LABORATORY VENTILATION MANAGEMENT

1. PURPOSE

This Notice establishes the requirements for the design, maintenance, testing, and operation of laboratory ventilation systems within APHIS and procedures used to prevent personnel from overexposure to harmful or potentially harmful contaminants generated within the laboratory. The information in this Notice will be incorporated into the Safety and Health Manual when it is revised.

2. SCOPE

This Notice applies to all laboratory facilities within the Agency.

3. BACKGROUND

The APHIS Safety, Health, and Environmental Protection Branch (SHEPB) has developed a comprehensive Occupational Safety and Health program to protect the safety and health of all employees in the Agency. Safety and health regulations and guidelines require the use of engineering controls (such as exhaust ventilation) as the primary means for minimizing the potential for occupational exposure to hazards in the workplace. Please note that chemicals, biological agents, and/or radioactive materials are never allowed to be used and/or stored in offices.

Engineering controls for protecting occupational safety and health will be designed into facilities for both new construction and renovated space. This proactive approach minimizes numerous common potential health and safety concerns in laboratory facilities. These health and safety guidelines will be incorporated, as appropriate, in facility-specific construction documents by the architect/engineer.

While many of the requirements for health and safety engineering are incorporated in these guidelines, it is unrealistic to cover all possible concerns. The design/engineering firm will, whenever possible, have a health and safety specialist on staff and will always consult with SHEPB personnel with regard to specific health and safety engineering requirements in the design of new construction and renovation projects.

4. REGULATIONS, STANDARDS, AND REFERENCES

a. National Fire Protection Association (NFPA) Handbook 45, Standard on Fire Protection for Laboratories Using Chemicals.

b. 29 Code of Federal Regulations (CFR) 1910.106, Design and Construction of Inside Storage Rooms.

c. American National Standards Institute (ANSI), Z358.1, Emergency Eyewash and Shower Equipment.

d. American National Standards Institute, (ANSI/AIHA) Z9.5–2003, Laboratory Ventilation.

e. "Ductless Fume Hood Review," Division of Occupational Health and Safety, Office of Research Services, Office of the Director, National Institutes of Health, 2005.

f. Laboratory Ventilation Management Program, National Cancer Institute-Frederick, 2009.

g. Stanford Laboratory Standard and Design Guide, Stanford University, 2005.

5. DEFINITIONS

a. **Absorption Filter.** A type of air cleaning device where contaminant molecules in the gaseous phase adhere to the surfaces of a solid material (adsorbent). Activated carbon is a popular adsorbent used for this purpose.

b. **Air Cleaning Device.** A component of a ventilation system designed to remove contaminant materials from an airstream. The mechanism of cleaning may include: particulate filters, solid adsorbents (activated carbon), wet scrubbers, electrostatic precipitators, and other cleaning agents.

c. **Auxiliary Air Hood.** A chemical fume hood equipped with a supply air plenum outside of the hood at the top and/or sides of the face opening to provide a downward-flowing airstream into the open face of the hood.

d. **Biological Safety Cabinet (BSC).** A special form of containment equipment (hood) featuring HEPA filtration used as a primary barrier to prevent the escape of aerosols into the laboratory environment. The various classes of BSCs can provide product protection as well as user protection.

e. **Bypass Hood.** A chemical fume hood designed so that, as the hood sash is lowered, a proportional fraction of the exhaust is drawn through an opening in the hood structure instead of the remaining open face.

f. **Chemical Fume Hood (CFH).** A box-like structure with one open side intended to contain and exhaust gases and vapors. The open side is equipped with at least one sash moving vertically or horizontally to close the opening. Various baffles and airfoils are incorporated to provide linear airflow across the face of the opening in accordance with ANSI Z9.5.

g. **Dilution Ventilation.** Ventilation airflow that diminishes contaminant concentration by mixing with contaminated airflow, as opposed to capturing the contaminant.

h. **Ductless Fume Hood.** A chemical fume hood that filters the exhaust air and returns it directly to the laboratory space.

i. **Exhaust Air.** Air that is removed from an enclosed space and discharged to the ambient environment.

j. **Face Velocity.** The air speed at the plane comprising the opening of an exhaust hood, which is usually an average of multiple observations within the plane.

k. **Filter Caisson.** An airtight housing for ventilation filters in facilities that handle hazardous materials. The housing usually has an upstream compartment for a pre-filter element and a downstream compartment for a high-efficiency filter element. It may have multiple sets of compartments. The housing has gasketed access doors to allow for the change out of the filter elements. The housing is usually equipped with connection points used to test the efficiency of the filters and monitor changes in the differential pressure across the filter media.

l. **Hazardous Substance/Chemical.** Any material that poses a threat to human health and/or the environment. Typical hazardous substances are toxic, corrosive, ignitable, explosive, or chemically reactive.

m. **High Efficiency Particulate Air (HEPA).** A designation given to a type of high efficiency air filter meeting a specification for minimum retention efficiency of 99.97 percent for 0.3 micron particles.

n. **Laboratory.** A building space, room, or operation used for testing, analysis, research, instruction, or similar activities. An area, exclusive of maintenance shops, is considered a laboratory if any of the following exists:

(1) Fume hood/biosafety cabinets or other primary barriers.

(2) Incidental use or storage of chemicals with any of the following properties: flammable, combustible, explosive, water sensitive, caustic, corrosive, high or unknown toxicity, carcinogen.

(3) Biohazardous material.

(4) Grinding operations (excluding metal).

(5) Radioactive material/ionizing radiation emanating equipment.

o. **Makeup Air.** Outside air drawn into a ventilation system to replace exhaust air.

p. **Room Air Balance.** The air pressure differential and direction of flow for room air with respect to adjacent spaces and within the room.

q. **Special Purpose Hood.** An exhaust device, other than a CFH or BSC, designed to capture gases/vapors/particulates from various laboratory equipment/operations (commonly chromatographs, flame/furnace spectrophotometers, dissection booths, liquid pouring stations, heat sources, etc.). These hoods might not meet the ANSI Z9.5 design criteria of a CFH, but they will meet applicable design criteria, as the design will be approved by SHEPB and tested for technical performance.

r. **Ultra Low Particulate Air (ULPA).** This can remove from the air at least 99.999 percent of dust, pollen, mold, bacteria, and any airborne particles with a size of 120 nanometers or larger.

s. **Variable Volume Hood.** A CFH designed so the exhaust volume is varied in proportion to the opening of the hood face by changing the speed of the exhaust blower or operating a damper in the exhaust duct.

6. RESPONSIBILITIES

a. <u>SHEPB</u> is responsible for reviewing building/renovation blueprints, approving laboratory ventilation equipment purchases, and conducting program audits and annual building inspections for compliance with this section. Program audits and building inspections may be delegated to occupational safety and health designees by SHEPB.

b. <u>Supervisors</u> will:

(1) Ensure a place of employment which is free from recognized hazards that cause or are likely to cause death or serious physical harm in accordance with the General Duty Clause of the Occupational Safety and Health Act of 1970.

(2) Ensure appropriate training is delivered and documented for employees tasked with using special laboratory ventilation equipment.

c. <u>Employees</u> are responsible for appropriately utilizing laboratory ventilation systems to prevent overexposure to potentially harmful contaminants generated within the laboratory.

7. GENERAL VENTILATION CONSIDERATIONS

a. The laboratory must have mechanically generated supply air and exhaust air. All laboratory rooms will use 100 percent outside air and exhaust to the outside. There will be no return of fume hood and laboratory exhaust back into the building. The air balance of the room cannot be adjusted unless there is mechanically generated supply and exhaust air.

b. Mechanical climate control must be provided. The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) 55-1992, defines comfortable temperature range as follows: Winter: 69–76°F (at 35 percent relative humidity); Summer: 73–79°F (at 60 percent relative humidity). Electrical appliances often exhaust heat into a room. Failure to take this effect into consideration may result in an artificially warm working environment. Windows must **not** be opened for a cooling effect since the room air balance will be altered. A cool room must not be heated with a portable heater that may be a fire hazard.

c. Cabinetry, other structures, or equipment must not block or reduce effectiveness of supply or exhaust air. Many supply diffusers and room exhaust/room openings are located along laboratory walls. Storage of boxes near these openings may obstruct the circulation of air and supply or exhaust air functioning.

d. General laboratories will have a minimum of 8 air changes per hour. The Occupational Safety and Health Administration (OSHA) requires a minimum of 8 air changes per hour in chemical storage rooms. Since most laboratories store some quantities of chemicals, this regulation applies. OSHA has cited chemical storerooms for inadequate ventilation under this regulation.

e. Laboratories must be maintained under negative pressure in relation to the corridor or other less hazardous areas. Clean rooms requiring positive pressure must have entry vestibules provided with door-closing mechanisms so that both doors are not open at the same time. As a general rule, airflow should be from areas of low hazard, unless the laboratory is used as a clean or sterile room.

f. Fume hoods must not be the sole means of room air exhaust. General room exhaust outlets will be provided where necessary to maintain minimum air change rates and temperature control. Air exhausted from laboratory work areas will not pass unducted through other areas. Hallways and corridors will not be used as return air plenums, and louvers will not be permitted in fire-rated doors. All exhaust air will be ducted. Interstitial space will not be used as a plenum to exhaust laboratory areas.

g. An adequate supply of makeup air (90 percent of exhaust) must be provided to the laboratory. Makeup air must be introduced at the opposite end of the laboratory room from the fume hood(s) and flow paths for room heating, ventilating, and air conditioning (HVAC) systems will be kept away from hood locations, to the extent practical. Makeup air will be introduced in such a way that negative pressurization is maintained in all laboratory spaces and does not create a disruptive air pattern.

h. Fume hoods must be located away from activities or facilities which produce air currents or turbulence, and away from high traffic areas, air supply diffusers, doors, and operable windows. Fume hoods must not be located adjacent to a single means of access to an exit. It is recommended that fume hoods be located more than 10 feet from any door or doorway. Fume hood openings must be located opposite workstations where personnel will spend much of their working day, such as desks or microscope benches.

i. An emergency eyewash/shower station will be within 10 seconds of each fume hood.

NOTE: Canopy hoods do not provide the same level of protection provided by a chemical fume hood and should not be used in lieu of a chemical fume hood.

j. Chemical fume hoods will operate continuously and must achieve a face velocity of 100 feet per minute (fpm) at an 18-inch sash height with a uniform face velocity profile of ± 20 percent of the average velocity. If equipped with a bypass, it will be designed so face velocity does not exceed the 120 fpm maximum as the sash is lowered.

k. Chemical fume hoods must have a flow-monitoring device connected to a local audio alarm and visual indicator within the laboratory where the alarm set point is 80 percent of design velocity.

l. Chemical fume hoods will have an airflow alarm which provides both an audible and visual alert with a ring-back feature adjustable from 5 to 15 minutes.

m. Equipment placed in the hood may restrict adequate exhaust air-flow. If absolutely necessary to have equipment in hood, position equipment toward back of hood and elevate equipment with blocks to maintain airflow gap below and around equipment to maintain air circulation. Only chemicals necessary to perform the experiment should be left in the hood; all other chemicals should be stored in approved safety storage cabinets. It is not advised to use a chemical fume hood to store hazardous waste unless the hood is not being used for any other purposes. Pouring of waste can be performed in the hood, and after the containers are capped, they should be placed in an approved safety storage cabinet.

n. Perchloric acid must be handled only in a designated Perchloric Acid Fume Hood. Water wash-down fume hoods made of noncombustible material must be utilized during use of perchloric acid.

o. All requirements relating to safety and health in the OSHA, Environmental Protection Agency (EPA) regulations, American Conference of Governmental Industrial Hygienist (ACGIH) Industrial Ventilation Manual, Standards of the ASHRAE, as well as local building and fire codes, must be met, at a minimum, to achieve a safe and healthy work environment. Where a conflict arises, the most stringent requirement will govern.

p. All laboratory chemical fume hoods and exhaust systems will comply with ACGIH guidelines as well as the guidelines presented in this chapter. Surfaces must be durable and easily cleanable. Service outlets will be located so that the operator will not have to reach into the hazard zone to make connections. Variable air volume and bypass hoods will be used in new construction and renovation.

8. CHEMICAL FUME HOOD EXHAUSTS

a. The discharge of air from chemical fume hoods will:

(1) Not be re-circulated.

(2) Be discharged in a manner and location to avoid reentry into the laboratory or adjacent building at concentrations above 20 percent of the allowable concentrations inside the laboratory under any wind or atmospheric conditions.

(3) Be in accordance with the latest relevant ASHRAE standards.

(4) Be located to avoid reentry, generally in a vertical-up direction at a minimum of 10 feet above the adjacent roofline.

(5) Be exhausted from a stack at a discharge velocity of at least 3000 fpm.

b. Aesthetic considerations concerning external appearance of the building will not be allowed to override these requirements.

c. Fume hood exhaust ductwork and exhaust fans will be constructed of corrosion-resistant material, such as stainless steel, or be coated with a protective corrosion-resistant product such as epoxy phenolic, or vinyl selected to resist the anticipated corrosive fumes.

9. DUCTLESS FUME HOODS

Ductless fume hoods are stand alone, bench top enclosures that use self-contained carbon and/or HEPA filters to remove fumes, vapors, and/or particulates from air drawn into the device and then re-circulated into the laboratory. The intent is to offer a replacement for a conventional chemical fume hood attached directly to the building exhaust system. For proper and effective use, filters must be discarded and replaced when they near a chemical saturation point. It is expensive to replace expended filters and to dispose of them as hazardous waste.

Ductless fume hoods have very limited applications in research laboratories due to the wide variety of chemicals used in most laboratories and should only be used with chemicals of low hazard and where the access to the hoods and the chemicals used are carefully monitored. NFPA 45 states that “air exhausted from laboratory hoods and other special exhaust systems will not be re-circulated.” The document goes on to say, “Ductless laboratory hoods that pass air from the hood interior through an absorption filter and then discharge the air into the laboratory are only applicable for use with nuisance vapors and dusts that do not present a fire or toxicity hazard.”

Under the ANSI/AIHA Z9.5 standard, a Hazard Evaluation and Analysis must be conducted for any ductless fume hood. Ductless fume hoods must have prominently posted signage informing operators and maintenance personnel on the allowable chemicals used in the hood, type and limitations of filters in place, filter change schedule, and a notice that the hood re-circulates air in the room. Warnings are included that many chemicals of low molecular weight can be stripped from the filter and reenter the room on the flow of air through the filter, resulting in a contaminant exposure to others in the room that is over a longer time span and at a lower concentration. Also, the collection efficiency and breakthrough properties of the filters may change where multiple air contaminants are used, resulting in earlier filter breakthrough. OSHA compliance officers have required quarterly monitoring of the hood exhaust to demonstrate the effectiveness of the filtration in the given application and the corresponding protection of the workers occupying the space.

The overall safety of APHIS employees should not be dependent upon a system considered by several Federal agencies and universities to be unreliable due to breakthrough, channeling, chemical selectivity, and sensor accuracy. This system also places undue reliance on personnel action for selection of proper filters, use of inappropriate chemicals once the filter medium is selected, regular maintenance and replacement of filters, turning equipment on and off before and after each use, and not allowing equipment to offered for surplus. Therefore, ductless fume hoods are generally not permitted; however, they may be used in limited applications such as inside of an existing chemical fume hood for a special application, such as odor control or dust control. Such applications **must** be reviewed and approved by SHEPB or their designee on a case-by-case basis.

10. BIOLOGICAL SAFETY CABINETS

General Requirements.

a. BSCs must meet the performance requirements and criteria included as part of the NSF/ANSI 49-2008 and must be NSF listed.

http://www.nsf.org/Certified/Biosafety/Listings.asp?TradeName=&submit1=SEARCH

b. The BSC will be listed by Underwriters Laboratories (or other approved testing laboratory) to meet the requirements for electrical/mechanical integrity. http://www.osha.gov/dts/otpca/nrtl/index.html

c. BSCs will be constructed of stainless steel forming an all-welded, monolith sealed structure. Cabinets must have ergonomic design to meet the American with Disabilities Act (ADA) requirements.

d. The supply air to the cabinet must be HEPA or ULPA (ultra-low penetration air) protected by a perforated metal diffuser covering the entire work zone.

e. Cabinets must have a gasketed seal between the filter assembly and the metal plenum.

f. All new cabinets purchased with ultraviolet (UV) lights must have safety systems integral to the cabinet to include interlocks, UV protective sash glass, and a standard operating procedure (SOP) for use. A caution sign will also need to be placed on the cabinet.

g. Cabinets are to operate continuously 24 hours per day, 7 days per week and must not have a night set back feature.

h. HEPA or ULPA filters must be easily accessed from the front of the cabinet.

i. Cabinets will accept utilities from the top of the cabinet.

j. Cabinets must have a digital visual and audible automatic air flow monitoring alarm with ring-back feature in which the audible alarm sounds every 5–15 minutes until the cabinet is repaired or removed from service.

k. The cabinet will meet or exceed all standards set forth for Biological Safety Cabinets as specified in the latest issue of NSF Standard 49.

l. BSCs should have a minimum of 12 inches clearance above the cabinet to permit access to HEPA/ULPA filters for maintenance and decontamination procedures.

m. BSCs are **not** chemical fume hoods and should **never** be used for such purposes.

11. PERCHLORIC ACID HOODS

General Requirements.

a. Perchloric acid will only be used in a laboratory hood specifically designed for its use and identified as “For Perchloric Acid Operations.” Perchloric acid salts are unstable and may explode with impact. For this reason, perchloric acid may not be used in standard chemical fume hoods.

b. Organic materials must never be used in a hood designed specifically for perchloric acid. Perchlorates are considered to be fire and explosive hazards when associated with carbonaceous material or finely divided metals. They react violently with benzene, charcoal, olefins, ethanol, sulfuric acid, and reducing materials. If perchlorates have accumulated in the perchloric acid fume hood, use of organics may create fire and explosion hazards.

c. The perchloric acid hood water wash down must be used regularly, preferably after each use. Inspect hood for any salts that may accumulate (even where automatic wash down is employed). Remove deposits with water.

d. Unnecessary organic materials must not be left in the perchloric acid hood. Fires and explosions may occur when perchloric acid contacts rags, sawdust, alcohol, cellulose, etc.

e. Particular caution must be exercised when using perchloric acid with strong dehydrating agents; for example, acetic anhydride or sulfuric acid. Under some conditions, particularly when using hot, concentrated materials, these agents may form dangerously explosive anhydrous perchloric acid.

f. All apparatuses used in perchloric hoods should be free of organic coatings and lubricants.

g. Spark producing apparatuses (including electrical outlets) should not be used inside a perchloric acid hood.

h. Perchlorate hoods, ductwork, and fans should be labeled with caution labels.

i. Perchloric acid hoods and exhaust ductwork will be constructed of materials that are acid resistant, nonreactive, and impervious to perchloric acid.

j. The exhaust fan should be acid resistant and spark resistant. The exhaust fan motor should be located within the ductwork. Drive belts should not be located within the ductwork.

k. Ductwork for perchloric acid hoods and exhaust systems will take the shortest and straightest path to the outside of the building and will not be manifolded with other exhaust systems. Horizontal runs will be as short as possible, with no sharp turns or bends. The ductwork will provide a positive drainage slope back into the hood. Ducts will consist of sealed sections. Flexible connectors will not be used.

l. Sealants, gaskets, and lubricants used with perchloric acid hoods, ductwork, and exhaust systems will be acid resistant and nonreactive with perchloric acid.

m. A water spray system will be provided for washing down the hood interior behind the baffle and the entire exhaust system. The hood work surface will be watertight with a minimum depression of 13 millimeters (mm) (½ inch) at the front and sides. An integral trough will be provided at the rear of the hood to collect wash down water.

n. Spray wash down nozzles will be installed in the ducts no more than 5 feet apart. The ductwork will provide a positive drainage slope back into the hood. Ductwork will consist of sealed sections, and no flexible connectors will be used.

o. The hood surface should have an all-welded construction and have accessible rounded corners for cleaning ease.

p. The hood baffle will be removable for inspection and cleaning.

q. Each perchloric acid hood must have an individually designated duct and exhaust system.

12. VARIABLE VOLUME HOODS

Variable volume hoods modulate supply air to maintain the design air balance between the laboratory and the adjacent areas. The mechanism that controls the exhaust fan speed or control damper position to regulate hood exhaust volume will be designed so exhaust volume is not reduced until the sash is half-closed. Then, it is reduced in proportion with the sash closure to a minimum of 10 percent full-open face volume.

If the maximum exhaust volume of variable volume hoods in one room exceeds 10 percent of the room air supply volume, and if the laboratory is designed for controlled airflow between laboratory and adjacent areas, automatic flow control devices will be provided to reduce the supply air volume by the same amount that the hood exhaust volume is reduced.

13. HVAC

a. Lab Supply Air. The laboratory general HVAC systems must satisfy research laboratory demands. Temperature and humidity must be carefully controlled to meet ASHRAE requirements. Systems must have adequate ventilation capacity to control vapors/gases, odors, and airborne contaminants; permit safe operation of exhaust hoods; and cool the significant heat loads which can be generated in the laboratory. Supply air quantities may not be fully established by the room-cooling requirements and load characteristics. Additional supply air required to make up the differences between room exhaust requirements and primary supply may be designated (1) infiltrated supply, if induced indirectly from the corridors and other spaces or (2) secondary supply, if conducted directly to the room.

(1) Laboratory HVAC systems will utilize 100 percent outdoor air, conditioned by central station air-handling systems to offset exhaust air requirements.

(2) Once supplied to a laboratory, air will not be re-circulated.

(3) Supply air volume will equal the exhaust volume less that of the air volume, if any, entering the laboratory through openings from adjacent spaces that interfere with planned airflow.

(4) Supply air distribution will be provided at jet velocities of less than half (preferably less than one-third) of the capture or face velocity of the exhaust hoods. For most hoods this imposes a 50 fpm or less terminal throw velocity at six feet above the floor. For laboratories with a large number of hoods, low-velocity perforated panels are necessary.

(5) Supply air quality will meet the technical requirements of ANSI/ASHRAE 62.

(6) That portion of laboratory noise generated by HVAC systems will be maintained at a maximum of 85 decibels (dB).

HVAC systems must be both reliable and designed to operate without interruption. HVAC systems must be designed to maintain relative pressure differentials between spaces and must be efficient to operate, both in terms of energy consumption and from a maintenance perspective. Federal energy standards must be achieved; however, opportunities for conserving energy resources will not compromise health and safety issues nor hinder continuous research functions. An energy monitoring control system will be provided in new construction and renovations, where feasible. Studies will be conducted during the design phase to determine the feasibility of utilizing heat-recovery systems in research laboratory buildings.

b. <u>Air Quality</u>. HVAC systems must maintain a safe and comfortable working environment and be capable of adapting to new research initiatives. In addition, they must be easy to maintain, energy efficient, and reliable to minimize lost research time.

(1) Adequate access will be provided for appropriate periodic maintenance and cleaning of HVAC system components.

(2) Outdoor air intakes will be located as far as practical (on directionally different dimension) but not less than 9.0 meters (m) from exhaust outlets of combustion equipment stacks, cooling towers, ventilation exhaust outlets from the building or adjoining buildings, vacuum systems, plumbing vent stacks, or from areas that may collect vehicular exhaust and other noxious air emissions. The bottom of outdoor air intakes serving central systems will be located as high as practical but not less than 1.8 m above ground level, or if installed above the roof, 1.0 m above the roof level.

(3) Exhaust outlets will be located a minimum of 3.0 m above ground, away from occupied areas or from doors and operable windows. The preferred location for exhaust discharge is above roof level. Care must be taken in locating potentially hazardous exhausts and discharges (e.g., engines, fume hoods, BSC's, kitchen hoods, spray painting booths, etc.) Prevailing winds, adjacent buildings, and exhaust discharge velocities must be taken into account to ensure that discharge is not entrained within an outdoor airstream.

c. Directional Airflow/Relative Pressurization/Airlocks. Control of airflow direction in research laboratories controls the spread of airborne contaminants, protects personnel from potentially hazardous substances, and protects the integrity of experiments. Airflow will be from areas of lower hazard to higher hazard, unless the laboratory is used as a Clean Room (such as Class 10,000 or better) or animal surgery rooms.

(1) Laboratories containing harmful substances will be designed and field balanced so that air flows into the laboratory from adjacent (clean) spaces, offices, and corridors (i.e., laboratories must remain at a negative air pressure in relation to the corridors and other non-laboratory spaces.)

(2) Administrative areas in a laboratory building must always be positive with respect to corridors and laboratories.

(3) Some laboratories, such as biohazard containment laboratories and tissue culture laboratories, require control of relative pressurization. The HVAC system must be capable of maintaining these special relative pressure requirements, which are presented in the Centers for Disease Control/National Institutes of Health publication Biosafety in Microbiological and Biomedical Laboratories. When flow from one area to another is critical to exposure control, airflow monitoring devices will be installed to signal or alarm a malfunction.

(4) For critical air-balance conditions (e.g., Biosafety Level-3 labs, clean rooms, etc.), a personnel entry/exit anteroom with controlled airflow and

electric door interlocks with emergency override and air flow alarms is required to provide a positive means of air balance control.

(5) Loading and receiving docks must be maintained under positive pressurization to prevent the entrance of vehicle exhausts.

d. Ventilation Rates. The ventilation rate for laboratory HVAC systems is driven by three factors: chemical fume hood and BSC demand, cooling loads and removal of vapors/gases, and odors from the general laboratory work area.

(1) The minimum air change rate for laboratory space is 8 air changes per hour regardless of space cooling load. For animal rooms, the minimum is 15 air changes per hour. Some laboratories may require significantly higher rates to support fume hood demand or to cool high instrument heat loads in equipment laboratories. Air changes may be reduced in half during unoccupied periods for **non-chemical laboratories** if it is possible to change back to normal working air changes if research/work must be done off hours; the room must remain in a negative pressure in relation to surrounding areas even with the lower flow rate.

(2) Implementation of a re-circulating-type HVAC system for administrative areas may be utilized for energy conservation. Re-circulating air systems will provide ventilation conforming to ASHRAE standards and must not affect the pressurization and balance between laboratory and administrative zones.

(3) Re-circulating systems of administrative areas will be completely separate from 100 percent outdoor air laboratory systems.

e. Exhaust Discharge Air Cleaning. Laboratory general exhaust air normally does not require filtration or scrubbing to meet EPA requirements; however, the use of dust-stop filters to prevent the accumulation of material on heat recovery devices may be warranted for preventive maintenance. In special laboratories using radioisotopes, certain hazardous chemicals/nano-materials, or in biocontainment laboratories, exhaust air may require special scrubbing or filtration before discharge to the atmosphere. Generally, for employee safety, this would necessitate the installation and use of bag-in/bag-out filter caissons.

f. Air Distribution. Air supplied to a laboratory space must keep temperature gradients and air turbulence to a minimum, especially near the face of the laboratory fume hoods and BSCs. Supply air outlets must not discharge into the face of fume hoods or BSCs. Large quantities of supply air can best be introduced through perforated plate air outlets or diffusers designed for large air volumes. The air supply will not discharge on a smoke detector, as this slows its response, or on a rate-of-rise heat detector, as it can cause false alarms.

14. MANIFOLD HOOD SYSTEMS

Two or more exhaust systems may be combined into a single manifold and stack if all the following conditions are met:

a. The manifold is designed as a plenum under negative pressure.

b. The exhaust stream components are chemically compatible.

c. Continuous maintenance of adequate suction in the manifold is provided by a backup manifold exhaust fan and emergency power to the manifold exhaust fans. When emergency power is not available, only hoods in the same room may be manifolded.

d. The minimum air change rate for laboratory space is 8 air changes per hour regardless of the space cooling load and for rooms with animals the minimum is 15 air changes per hour. Some laboratories may require significantly higher rates to support fume hood demand or to cool high instrument heat loads in equipment laboratories. Air changes may be reduced in half during unoccupied periods for **non-chemical laboratories** if it is possible to change back to normal working air changes if research/work must be done off hours; the room must remain in a negative pressure in relation to surrounding areas even with the lower flow rate.

15. AIR CLEANING

a. Supply Air. Lab supply air systems seldom require air cleaning for health and safety reasons. Supply air can be provided for technical reasons, usually to reduce the contamination from atmospheric dust and dirt. The filtration necessary for supply air depends on the activity in the laboratory. Conventional chemistry and physics laboratories commonly have 85 percent efficient filters, based on ASHRAE Standard 52-76 Test Method. Biomedical laboratories usually require at minimum 85 percent efficient filters.

   (1) Preventive maintenance obligates supply air for all laboratory systems to be filtered on the upstream side of fans with at minimum 30 percent efficient pre-filters and at minimum 85 percent efficient after-filters.

   (2) HEPA filters may be warranted in special laboratories where research materials or products are particularly susceptible to contamination from external sources. HEPA filtration of the supply air is considered necessary in only the most critical applications such as environmental studies, dust-sensitive work, and electronic assemblies. In many instances, conducting sensitive work in a BSC, rather than providing HEPA filtration for the entire room, is satisfactory. HEPA filtration will be provided as required by the program requirements for individual applications.

b. Exhaust Air - Room HVAC. Generally, room HVAC systems do not require air cleaning prior to release to the environment. SHEPB will review program requirements to determine the need for cleaning general exhaust from laboratories (i.e., areas used for work with select carcinogens, select biohazards, reproductive toxins, nano-materials, or substances which have a high degree of acute toxicity). In cases where air cleaning devices are installed, exhaust filter assemblies will be provided with a damper, instruments, and controls that:

(1) Actuate a motor to open damper from initial partially closed position when filters are clean to a full open position when filters are fully loaded.

(2) Actuate a signal or alarm when the pressure drop across the primary or secondary filter reaches 0.1-inch water gauge (w.g.) more than the rated pressure drop.

(3) HEPA filter installations will be tested for leaks, all leaks repaired, or the filter replaced before use.

(4) Bag-in/bag-out filter caissons that greatly reduce or eliminate worker exposure are to be used whenever feasible.

(5) Bag-in/bag-out filter caissons will be equipped with aerosol challenge test ports for in-situ testing of HEPA filters.

(6) Bag-in/bag-out filter caissons will be fitted with 100 percent dampers to permit filter decontaminations.

(7) Indicate static pressure differential separately across primary and secondary filters and the pressure differential across both filters and the damper.

16. PREVENTIVE MAINTENANCE AND FILTER REPLACEMENT

a. Hood users will be notified before any maintenance is to be performed so work in the hood can be halted during maintenance.

b. Maintenance personnel will use appropriate personal protective equipment as needed (e.g., respirators, goggles or face shields, gloves, and protective clothing) whenever work involves hazardous exposure.

c. Equipment to be removed to the shop will be decontaminated before removal.

d. Equipment being shut down for inspection or maintenance will be secured (locked/tagged out) during such maintenance.

e. All toxic or otherwise dangerous materials on or in the vicinity of the equipment will be removed or cleaned up before maintenance.

17. TESTING AND INSPECTIONS

a. Local exhaust systems (CFH and special purpose hoods) will be evaluated every 12 months, or as needed after repairs or maintenance, and records maintained of test results and ventilation system modifications.

b. Instruments using electrical, electronic, or mechanical components will be calibrated in accordance with the manufacturer's recommendations before use or after any possible damage (such as dropping the test meter).

c. Emergency bypass dampers will be tested by applying the appropriate control signal and observing the damper movement for the full range of designed operation.

d. Other dampers and associated drive linkage and actuators will be inspected visually and the actuator operated enough to observe proper movement.

e. Air filter gauges will be read and inspected at least annually. If the pressure differential exceeds the rated maximum, the filters will be changed at the first opportunity.

f. Exhaust flow rate from hoods will be tested by measuring the flow in the duct by the hood throat suction method or by a flow meter. If flow measurement in the duct is not practical, velocity at the hood face will be measured. If the flow rate differs more than 10 percent from design, corrective action will be taken.

g. Fans, blowers, and drive mechanisms will be visually inspected annually for abnormal noise, vibration, abnormal motor temperature, lubricant leaks, etc.

h. V-belt drives will be stopped and inspected annually for belt tension and signs of wear or checking.

i. A routine performance test will be conducted on every fume hood at least semi-annually or whenever a significant change has been made to the operational characteristics of the system. If face velocity is used, the face of the hood will be divided into 12 or more imaginary rectangles of approximately equal area and velocity measured. Each hood will maintain a face velocity of 100 fpm with a uniform face velocity profile of +/-20 percent of the average velocity with the sash fully open.

18. INQUIRIES

a. Inquiries regarding this Notice should be directed to the APHIS Emergency Management, Safety, and Security Division, SHEPB, at 301-734-8958.

b. This Notice can be accessed on the Internet at: ***www.aphis.usda.gov/library***

/s/
Joanne Munno
Deputy Administrator
MRP Business Services